the Missouri and Mississippi and their many navigable tributaries; it was hastened by the presence of lead, a most desirable metal for the trader, and by the fur trade. As elsewhere in America, a skirmish line of traders preceded the settlers. The journeys of Marquette and Joliet and of La Salle late in the seventeenth century opened the way for the trader, and very early in the next century lead was found in eastern Missouri.

By 1703, it is a matter of record that French explorers had been guided up the Missouri, which at that time was believed to afford a passage to the Pacific, and it is probable that unrecorded voyages had been made before that time. The French were primarily traders and not settlers, and followed a fur supply that rapidly receded westward. The record of their explorations is to be found in the numerous place-names of streams along the Mississippi and Missouri. The easy pathway, therefore, afforded by the rivers both from the north and from the south, together with the accessible lead ore in south-east Missouri, expedited the early exploration by the French.

The census of 1790 shows a fairly dense population along the Mississippi flood-plain below St. Louis. Here the river for the most part flows along the western side of its broad valley leaving a wide, fairly continuous lowland to the eastward (Fig. 30). Accessibility, fertile and easily-tilled land and the lucrative fur trade, located here a zone of French settlement. Considerable quantities of bacon and flour were exported down the river to New Orleans and up the river to St. Louis; the fall of the streams flowing eastward from the Ozark border afforded water power by which the flour was manufactured. The lead region of the eastern Ozarks was settled by Americans and Frenchmen; Mine La Motte, Bonne Terre, and other place-names of towns recall the French element in the population. The Lewis and Clark expedition in 1804 advertised the state and opened the way for further exploration and settlement.

(To be continued.)

THE EXPLORATION AND SURVEY OF THE 141ST MERIDIAN, ALASKA.*

By DOUGLAS H. NELLAS.

THAT part of the 141st meridian which forms the International Boundary line between Canada and Alaska, starts at the south end at a point where the meridian intersects a ridge running out in a westerly direction from Mount S. Elias, and continues north to the Arctic ocean.

In 1866–67 gold was reported along the Yukon river, and after 1880 numerous discoveries of gold were made on the Lewis, Pelly, Stewart, and other streams of the upper Yukon country in Canada. In 1883–85 there was considerable excitement due to these discoveries, and a much greater one in 1887 after the discovery of coarse gold on Forty Mile creek in American territory. In this year (1887) Mr. William Ogilvie, a Canadian officer, was sent into the Yukon to establish provisionally the 141st Boundary Line on the Yukon river. The longitude of this point he first attempted to fix by occultations of stars by the moon, but was unsuccessful owing to cloudy weather, so that the moon-culminating-star method was finally adopted, with a result that was found to be but very slightly in error later on when the longitude was determined by telegraph. Shortly after this the line was produced 45 miles south, and in 1902 Mr. J. J. McArthur produced it 86 miles further on.

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* Map, p. 96.

In 1906 a treaty was signed providing for the manner of making the final survey and demarcation of the 141st meridian. First of all, the meridian was established at its crossing of the Yukon river by exact telegraph longitude in the following manner: The telegraph line from Dawson, Yukon, to Fort Egbert, Alaska, follows the Yukon river across the meridian. From Dawson communication with the south is had by the Government line to Ashcroft, B.C., and thence by the Canadian Pacific Railway telegraph to Vancouver. Fort Egbert is connected by a telegraph line built by the United States Government, with Valdez, Alaska, from which communication is had with Seattle by cable. The longitude of Vancouver had already been determined by observations which are printed in the chief astronomer's report for 1905. That of Fort Egbert was determined by the United States Coast Survey in 1905. A double determination of longitude at the meridian was therefore possible, and was decided upon. Mr. Tittmann sent an observer, Mr. Smith, to Fort Egbert, while Dr. King detailed Dr. Klotz for the Vancouver observations, and Mr. F. A. McDiarmid for those at the presumed location of the 141st meridian.

During the following winter the whole longitude net including the stations at the 141st meridian, Vancouver, Winnipeg, Ottawa, Montreal, Harvard, U.S.A., Seattle, and Fort Egbert, was adjusted by least squares, and the offset in feet from Boundary Station to the true meridian of 141st longitude computed.

In 1907, M. A. J. Brabazon, D.L.S., was appointed in general charge of the survey of the 141st meridian under the Canadian Commission. Early in the spring, before the snow was off the ground, a Canadian officer and an American officer were sent in to observe for azimuth. The method used was that of micrometer measurements of circumpolar stars when near the meridian, with reference to a target about one mile distant from the instrument. The probable error of the Canadian observations was 0·18″, the American 0·50″. The difference between the mean of their sets was 1·00″. Mr. Ogilvie's provisional line was found to be 369 feet too far west; while that of Mr. Turner, the American officer who established the provisional line on the Porcupine river, was found to be 1000 feet from the true position.

During the seasons of 1907 and 1908 the meridian was projected and surveyed south from the Yukon river a distance of 225 miles, to where it strikes a shoulder of Mount Natazhat at the head of the White river. The country from here to Mount St. Elias is totally unexplored, and is so rough and mountainous that it is probable that the meridian will not be projected from there at present, although it is the intention of the commission to make a topographical survey of the region and map it.

In 1908 the author received instructions to run a line of geodetic levels from the boundary at White Pass to station "G. South," on the 141st meridian, *viâ* White Pass railway (89 miles), the Whitehorse-Dawson waggon road (336 miles), the Dawson-Glacier waggon road and pack trail to the station (76 miles), making a total of 491 miles. The closing error for the total distance was 0·0439 foot. The American Commission installed a tidal gauge at Skagway, which was attended to daily by an observer for three years. At the end of this time they ran a line of geodetic levels from the gauge some 20 miles, and connected with the Canadian benchmark at White Pass. In this way the mean sea-level was carried through to the meridian survey, the levels being finished in 1910. When the connection was made it was found that the assumed elevation used in connection with the triangulation and the topography, with aneroid readings for a base, was only 36 feet out. The method used in this survey was the same as that followed under the instructions issued to the observers of the Geodetic Survey of Canada, but was varied a little here and there to suit the character of the country and the conditions encountered. The average length of sight in the section from Whitehorse to the Pelly river was 157 feet, from the Pelly river to the Stewart river 85 feet, from Stewart river to Eureka creek 81 feet, and from Eureka creek to station "G South" 144 feet.

In 1909 Mr. Brabazon was appointed in charge of the boundary line along the St. Croix river, and Mr. J. D. Craig was appointed in general charge of the survey of the 141st meridian. During 1909 the line was projected 40 miles north from the Yukon river, and an exploration made up the Black and Porcupine rivers to find out the best method of transporting supplies to the north part of the line between the Yukon and Porcupine rivers. The Black river is navigable in the season of high water, which is just after the ice goes out in the spring, with a gasoline launch capable of pushing a scow holding eight tons up as far as the boundary line. An 80-ton river steamboat can go up the Porcupine river 60 miles beyond Rampart House (which is situated where the boundary line crosses the river) to the mouth of the Old Crow river, at the time of high water, and a gasoline launch has been taken up as far as Lapierre House, which is situated near the mouth of the Bell river. The Old Crow river empties into the Porcupine river about 60 miles above Rampart House; from its mouth in a straight line to where it crosses the boundary line is about 60 miles, following the windings of the river it is 300 miles. In high water a gasoline launch can go up it to the boundary line. In 1910 the line was projected 150 miles further north to a point 7 miles north of Rampart House, and in 1911 the author took charge of the projection party, and projected it through to a point about 7 miles from the shore of the Arctic ocean.

The general organization of the survey was as follows: Projection party (Canadian), the personnel was composed of nine men all told, and was divided into three sub-parties. The fore-helio party was in charge of an assistant surveyor, who had with him a packer and a cook. His outfit consisted of eight horses, one tent, a reflector, cooking outfit, a box heliograph (3 inch), and tools for putting in stations. The observing party consisted of the author, a United States officer, a cook, and a packer. They had two tents, eight horses, a small two-holed folding stove to cook with, an observing theodolite, a 5-inch Cook heliograph—British army model—an instrument wind shield, and a small shelter tent for use at the observing stations. The rear-helio party consisted of a Canadian and a United States heliographer. They had three pack-horses, one tent, a reflector cooking outfit, and a box heliograph (3 inch).

The method of observing for the projection of the line was as follows: We had a 7-inch theodolite reading to ten seconds, with a vertical circle reading to thirty seconds. The telescope was fitted with a micrometer eyepiece, with the valve of a micrometer division equal to 2·3″. The proper reading for the micrometer when the midway point between the vertical hairs was in collimation, was found at the first of the season by pointing at a mark and reading the micrometer, then reversing the telescope in the wyes and setting the wires on the point by the micrometer screw and taking another reading, the average of these readings being the collimation reading. This reading was found in the computing of each of the sets, and remained about the same all the summer. When ready to start work, the rear party had their heliograph set over the second to last station established, the observing party at the last station, and the fore party on a mountain ahead in the vicinity of the new station. When both lights were shining, the instrument was carefully levelled, the micrometer set at collimation and pointed at the rear light. The telescope was then transited through, and our own heliograph lined up on the fore party and a message sent telling them to move east or west as the case may be, until they were seen between the wires on the approximate line. An O.K. was then sent, and they proceeded to put in two reference points, one east and one west of the line, and about one and a half metres apart. These points were established by drilling a hole in the centre of a cross cut in a large flat rock set flush with the ground, or in solid rock when possible. The heliograph was then set up over the west point and the light turned on the observing party. The programme of micrometer observations to fix accurately the position of the line ahead was then proceeded with as follows: The micrometer line was set approximately at the reading for which it had no error of collimation. The telescope was then pointed approximately at the south light in the direct position, using the upper or the lower tangent screw. The position of the instrument was recorded by the letters C.E. or C.W. corresponding to circle east or circle west. Immediately before each set (never during a set) the horizontal was tested with the striding level and levelled when necessary. The horizontal circles were left clamped and neither of their tangent screws touched during a set.

Commencing the set (telescope C.E.), three pointings were made on the south light with the micrometer; the telescope was then transited through and three pointings made on the north light with the micrometer (telescope C.E.). The telescope was then lifted out of and reversed in the wyes and three pointings made on the north light (telescope C.W.), then transited through and three pointings made on the south light (telescope C.W.). This constituted one set. Three such sets were taken alternately by the United States officer and the author, making six in all. The mean of our three sets had to agree with each other to 0·022′ of the micrometer circle, which is equal to five seconds in azimuth. If they did not, more sets were taken until the mean of all sets taken did agree within this amount. A set was not discarded unless for some very good reason, such as a long wait for light. The mean of these six or more sets gave the angle of deflection of the west point from the true meridian in terms of micrometer intervals, and as soon as satisfactory results were arrived at, the signal "O.K. one" was sent ahead and the fore light moved to the east point, whose deflection was determined in a similar manner. In computing the deflection given by one set, two methods were used, one to check the other. The formula for the shorter method is as follows:—

$$\text{Angle of deflection} = \frac{(\text{C.E. South} - \text{C.W. North} \pm (\text{C.E. North} - \text{C.W. South})}{2}$$

The sign of the enclosed expression is the sign of the smallest quantity east or west as the case may be. It sometimes happens that one expression gives east and the other west; in this case the sign between them is minus, and the sign of the result is the sign of the larger. The longer method used for checking is as follows:—

$$\text{Angle of deflection} = (C' - \text{C.W. South}) \pm (C' - \text{C.W. North})$$

$$\text{when} \qquad C' = \frac{\text{C.E. South} + \text{C.E. North} + \text{C. W. North} + \text{C. W. South}}{4}$$

The following are two sample sets observed at “X” station, and also the results of all sets together with the computation necessary to establish the position of “Y” station. Having the distance in micrometer intervals between each point and the true meridian, their sum is the distance between points; having received this distance by heliograph, the computation is a simple proportion, namely, the total distance in metres : the total distance in micrometer intervals : : the distance of the west point to the line in metres : the distance of the west point to the line in micrometer intervals.

SAMPLE COMPUTATION.

“X” STATION.

W.B.G.

C.E. 14·644 14·646
W. ·650
·643
C.E. 14·612 14·604
Y. ·602
·599
C.W. 14·620 14·614
Y. ·612
·610
C.W. 14·631 14·634
W. ·633
·638
4)58·498
14·625 14·625
14·614 14·634
·011 ·009
0·11
W. ·002
W. ·032
E. ·030
2)·002
W. ·001

August 6, 1911.

D.H.N.

C.W. 14·625 14·613
W. ·607
·608
C.W. 14·605 14·593
Y. ·586
·588
C.E. 14·630 14·624
Y. ·612
·629
C.E. 14·590 14·583
W. ·580
·578
4)58·413
14·603 14·603
14·613 14·593
·010 ·010
0·10
W. ·000
W. ·011
E. ·010
2)·001
W. ·001

WEST POINT.

W.B.G.	D.H.N.
W. ·005	W. ·007
W. ·001	W. ·001
E. ·005	W. ·005
3)·000	·013
W. ·000	W. ·004
	W. ·000
	2)·004
	W. ·002

EAST POINT.

W.B.G.	D.H.N.
E. ·108	E. ·117
E. ·122	E. ·125
E. ·128	E. ·132
3)·358	·374
E. ·119	E. ·125
	E. ·119
	2)·244
	E. ·122
	W. ·002

Total = ·124 Micrometer divisions.
Total = 1·722 Metres between west and east points.

1·722/·124//X/·002
·002
·124)·003444
·028 The line is ·028 metre east of the west point at station “Y.”

The points as fixed by the projection party are taken as being absolutely correct in longitude, that is, 141° 0′ 0″, and when the least-square adjustment of the triangulation is made in the office, the whole triangulation net between bases is adjusted to the projection stations. It was found that the most economical distance between stations was 10 miles, although in some cases, where there were no hills suitable for a station, sights were taken as long as 25 miles. One station, when projecting the line south, was put in on a 60-mile sight, but more time was wasted than if they had gone along on shorter sights. The stations are marked on the ground by a drill-hole in the centre of a cross cut in the solid rock or in a large flat rock set flush with the ground.

Triangulation Reconnaissance Party.—Following the projection party came a triangulation reconnaissance party, consisting of the chief, one assistant, a cook, two packers, and fourteen horses. They located the triangulation stations and built the signals, which this season consisted of a flag-pole with a symmetrically built cairn around it. They had a plane-table with them, and from two established stations cut in all the mountains ahead in the vicinity of proper places for new stations; the two in the best positions were climbed, and if they fulfilled the other conditions, such as seeing ahead, etc., were established as stations. If a diagonal could not be read, an interior point was put in, making a five-point figure. They tried to make the quadrilaterals 8 miles long and 10 miles wide, so as to have the distant angles large.

Triangulation Observing Party (*United States*).—This party consisted of a chief, a recorder, a cook, two packers, and nine horses. Their instrument was a 7-inch Berger horizontal circle reading to ten seconds, and vertical circle reading to thirty seconds. The observing was done under the U.S. Coast and Geodetic Survey instructions for tertiary triangulation, but as the average closing error for the triangles generally came to two or three seconds, it could be classed as secondary. The chief and his recorder kept the geographical positions and the elevations of their stations computed up to date. These data were given from time to time to the topographers to put on their plane-table sheets to control their topography.

Topographic Party (*United States*).—Following the observing party came the topographic party consisting of a chief, an assistant topographer, two recorders, two traverse men, two rodmen, a cook, two packers, and fourteen horses. They used the plane-table method of mapping, and covered a strip of country 4 miles wide, 2 miles on each side of the line. The traverse men traversed the creeks and lakes, and the topographers went along the ridges, making stations here and there, and tying themselves in by the three-point problem from sights on the triangulation stations. As the work is done so quickly in the field, and all the time used for getting information, the results, which are on four sheets, namely the topographers', the assistant topographers', and the two traverse men's sheets, take all winter to compile into the final map.

Line-cutting and Monumenting Parties (*Canadian*).—There were in 1911 two parties, one working south of the Porcupine river, and one north of it. They were composed of a chief, two assistants, two cooks, two rodmen, three packers, and three labourers. Where the bush is thick, as near the Yukon river, a party can do from 50 to 70 miles in a season of three and a half months. The party working north this year did 100 miles of line in 66 days. The line is transited in the usual way in between projection stations, and a 20-foot skyline cut out through the bush. Bronze monuments are put in on the prominent ridges and at river crossings, the instructions calling for them to be placed at a distance of not greater than 4 miles apart, and to be intervisible. The average distance at which they are placed is about 3 miles. A stadia line is run between monuments to get an accurate measurement of the geographical features. Two 4-inch transits reading to one minute are used, one for the stadia work, and one to read the triangulation angles from which the geographical position of the monuments are computed.

Transportation Parties.—There were two Canadian and two United States pack-trains to help out in the transportation of supplies. Both Governments built a 25-horsepower gasoline launch, and rented another apiece to transport supplies. One of these launches had a mileage of 5000 miles to her credit at the end of the season, and the other 4500 miles.

Route from Porcupine River north to Arctic Ocean.—The trail followed is shown on the accompanying map, and is good except that portion between "R" and "S" stations which crosses the Old Crow flats, and this, although wet, has a hard bottom. The mountain passes are all good except the pass at "X" station, which is 3900 feet in elevation, very rocky, steep, and practically impossible for horses unless a trail is built; there is, however, a good pass through this range about 5 miles to the east of the line. It is shown on the map in red.

Vegetation.—The location of the spruce timber is shown on the map in green; on the hills it runs up to 7 inches in diameter, along the creeks some of the trees are 14 inches, and hold it well up to the top. Where the timber is there is practically no underbrush. The valley of Sunaghun creek is thickly covered with buckbrush (Arctic birch), with patches of spruce along the creek. The flats at the mouth of Rapid river are covered with a young growth of spruce, with heavy timber along the stream and tributaries. The bush goes up the mountain-sides in patches not higher than 300 or 400 feet, and disappears altogether from the valley about 3 miles west of line.

All the tributary streams at the headwaters of the Old Crow river have spruce up to 14 inches along their banks; this extends in places up the mountain-sides as high as 300 or 400 feet, and cover many of the low ridges, but the growth is much smaller, there being very little underbrush, and the ground covered with moss. In this district, where the ground in the valleys is not covered with bush it is covered with buckbrush and willows.

The valleys of the Firth river and its tributaries have spruce bush similar in size and location to those of the Old Crow river, but not in such large quantities. It extends north as far as the British mountains, beyond which we were unable to see, the valley at this point being about 15 miles from the line. Black poplar was found in small quantities on all streams up to the British mountains. The hillsides of "X" river and tributaries were the only places that we saw alder in any quantities.

Beyond the British mountains in travelling to "Y" station we did not see any timber of any description, the only vegetation being reindeer moss, heather, and small patches of willow bushes up to 2 inches in diameter. There were also small patches of grass, but not in any great quantity. Parties working in this country next year will have to take in nearly full rations of hay and oats for their horses. This refers to the country north of the British mountains; south of them there is plenty of fine grass for horses. All through the country from Rampart House to the sea there are large quantities of blueberries and ground cranberries.

Rivers.—Between Rampart House and the Arctic ocean there are only two rivers of any size, the Old Crow which flows into the Porcupine, and the Firth which flows into the Arctic ocean, and these are crossed near their headwaters. The Old Crow has a cross-section of about 10 inches deep and 20 feet wide in low water, and about 3 feet deep and 150 feet wide in high water at the trail crossing. The Firth river, at a place 1 mile west of line, at a time of average water, had a cross-section of about 3 feet deep and 100 feet wide. Mancha creek carries at its mouth about a third as much water as the Firth. The remaining larger streams, Case, " W," " X," and " Y," carry at their mouths about as much water as Mancha creek.

Near the line on the Firth river is a glacier about half a mile wide and 2 miles long, and some of its tributaries have smaller ones a few hundred yards wide and half a mile long. They are formed by the river freezing during the cold winter, and for the most part disappear during the summer. From Rampart House to the Arctic ocean no signs of ice markings were seen, and the British mountains, which are the highest and most rugged along the line, were entirely bare of snow and ice, although off to the west we could see high snow-capped mountains.

Game.—Very little game was encountered up to " W " station. In this vicinity sheep and cariboo were numerous. The cariboo seemed to have moved up to this district during the extreme hot weather of June and early July, and to have started south about the middle of July, so that about the middle of August there was a herd of a thousand in the vicinity of Rapid river. At all times we came across numbers of ptarmigan, and in the willows along the Porcupine river rabbits and grouse were very plentiful.

Map.—As before mentioned, the topographers only mapped a strip of country 2 miles on each side of the line. The author thought it was a pity that more geographical information was not brought out of the country, so in his spare time, while waiting for light at the projection stations, he made a sketch-map of the country as far as he could see on each side of the line on a scale of 8 miles to an inch, the projection stations being used as bases. The accompanying map has been drawn from the one made in the field.

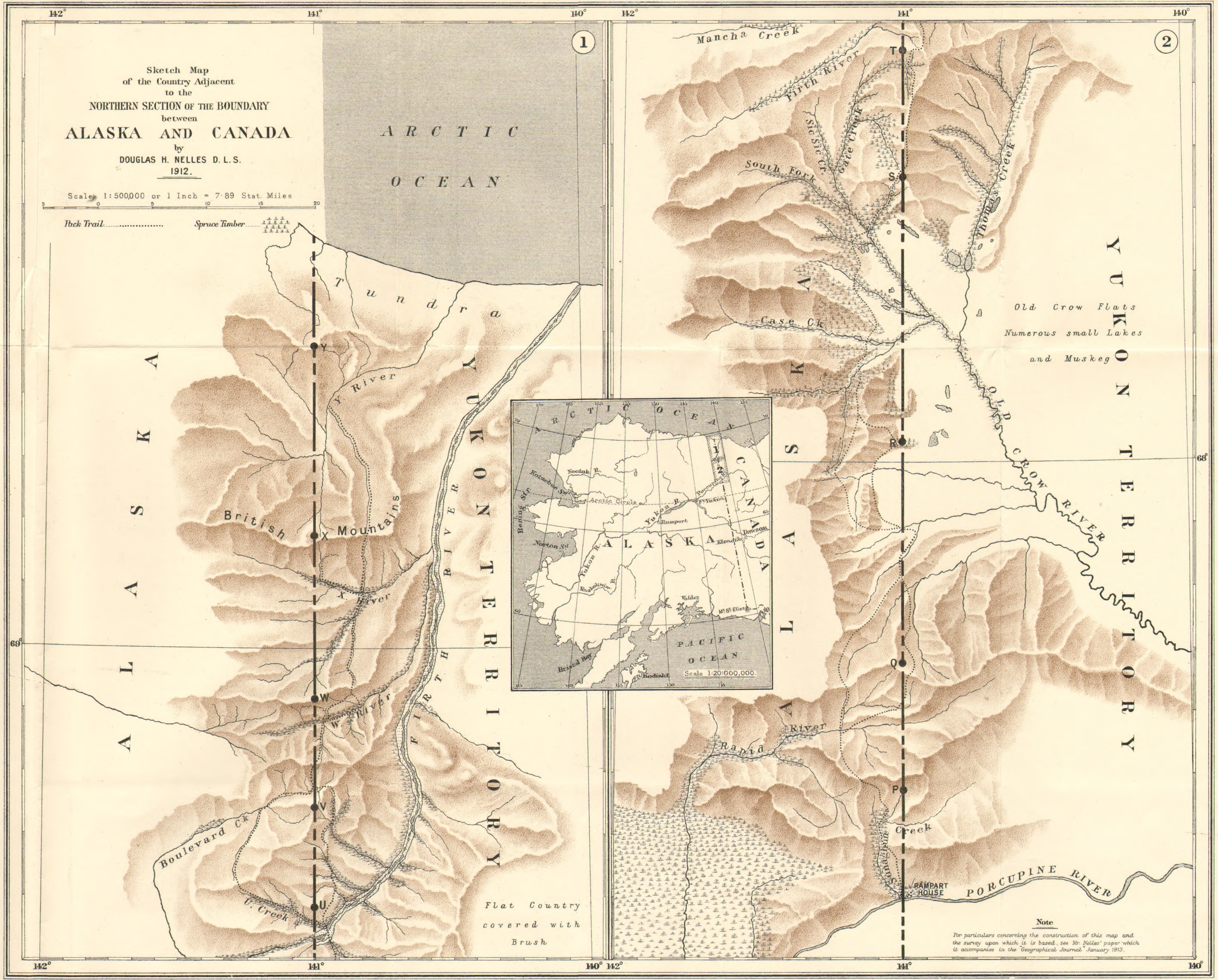
REVIEWS.

EUROPE.

THE ORDNANCE SURVEY.

'Report of the Progress of the Ordnance Survey to the 31st March, 1912.' London Wyman & Sons. 1912. *Price* 10*d.*

THE annual report by the Director-General of the Ordnance Survey records a familiar tale of progress and efficiency. The department appears to be able to keep pace with the rapidly increasing demands both on the part of the public and by other Government offices for maps and plans of all kinds, cadastral, topographical, geological, and many others. These demands show no sign of diminishing in the future, and, as the report points out, the ever-increasing complexity of the business of the great Departments of State requires more and more the assistance of graphical methods. Thus there has been imposed upon the Ordnance Survey, by a process of gradual accretion, the duty not only of mapping the country, but of supplying all sorts of cartographical material, such as census diagrams, maps of canals and waterways, maps showing the distribution of the Territorial Army, and the density of London traffic. Seeing the weight of work, by no means all of a routine character, thus thrown upon the Survey, one can hardly be surprised that at times the prime object of its existence, the scientific mapping of these islands, would appear to have been almost buried



Sketch Map
of the Country Adjacent
to the
NORTHERN SECTION OF THE BOUNDARY
between
ALASKA AND CANADA
by
DOUGLAS H. NELLES D. L. S.
1912.

Scale 1:500,000 or 1 Inch = 7·89 Stat. Miles

Note

For particulars concerning the construction of this map and the survey upon which it is based, see Mr. Nelles' paper which it accompanies in the "Geographical Journal" January 1913.

Published by the Royal Geographical Society